(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 137 318 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.09.2001 Bulletin 2001/39

(51) Int Cl.[7]: **H04R 1/34**

(21) Application number: **01830160.6**

(22) Date of filing: **08.03.2001**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **21.03.2000 IT BS000025**

(71) Applicant: **OUTLINE S.N.C. DI NOSELLI G.& C.**
25020 Flero (Brescia) (IT)

(72) Inventor: **Noselli, Guido**
25020 Flero, Brescia (IT)

(74) Representative: **Manzoni, Alessandro et al**
MANZONI & MANZONI,
UFFICIO INTERNAZIONALE BREVETTI,
P.le Arnaldo n. 2
25021 Brescia (IT)

(54) Wide-band diffusor, with high efficiency and high directivity

(57) The invention concerns a wide-band sound diffuser with high efficiency and directivity, consisting in a body, a front reflecting parabolic element (13), at least one active element (11) at the centre of said reflecting element, and a horn (12) which expands from the rear and around the reflecting element with a progression starting from the active element to the emission mouth (16) facing in the same direction as the reflecting element. The reflecting element has a front emission in the direction of the mouth of the horn and a rear emission directed towards the horn.

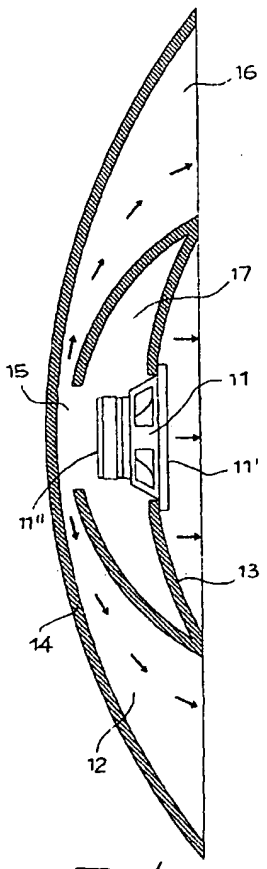

Fig.1

EP 1 137 318 A2

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention concerns wide-band sound diffusers.

The modern requirements for reproducing music and the human voice, whether live or recorded for professional reasons and other, require the use of appropriate diffusers and, consequently, their manufacturers all tend to respect the typology described below. This adaptation, however, can not take into consideration just the needs of sound reproduction, given that such diffusers must be able, as part of their intrinsic characteristics, to limit their contribution to sound pollution as much as possible when they are in function. In the industrialised societies of today, sound pollution has become too high and is tenaciously fought by laws which are becoming increasingly specific and severe.

[0002] Therefore, on the one hand, the need for sound amplification sees the use of high quality diffusers, with high performance, elevated power stability and capacity for generating high volumes across the audio band, to give faithful reproduction of all source types, including digital, with particular reference to the intelligible reproduction of the speaking voice, even when the acoustic conditions are unfavourable, while, on the other hand, such diffusers must not emit signals or sounds into the surrounding environment which are too high, at the risk of damaging human health and the environment itself, not to mention the financial sanctions due to violation of sound pollution laws, which are omnipresent nowadays.

[0003] However, these two needs are difficult to reconcile, given that they derive, to a certain extent, from contrasting ends.

[0004] The aim of this invention is to propose a special diffuser which reconciles these two opposing needs, respecting them and not compromising them, neither in the acoustic performance attributed to the diffuser for the reproduction of the speaking voice and/or music, nor in the emission of undesired signals and sounds into the surrounding environment.

[0005] Analysing the possible systems for sound translation that have been proposed to date by the state of the art and the market, only one of these can be successfully used to reach all the objectives set, respecting not only these, but also the need for economy of construction, which may be decisive for its potential use.

[0006] Such a system must inevitably have high directivity and be of the horn type. In this case, a horn system of a special kind which can be perfectly adapted to the use. In reality, it is possible to make systems which are perfectly directional, and not necessarily horn-type; but such systems, generally made to exploit the greater directivity that many direct radiation sources (generally, wide-band loudspeakers with small diameter), placed side-by-side on a flat surface (baffle), acquire via interference or beat, do not meet the efficiency and quality requirements and, therefore, the performance/price ratio, which are amply respected, on the other hand, by the system here described.

[0007] Nowadays, it is possible to affirm, as shown by the abundant literature on the argument, that the horn system is, by its very nature, the only type of diffuser capable of reconciling efficiency, quality, directivity and at a reasonable cost for the superior performance, thanks to the great saving which is due both to the use of one or very few active elements (loudspeakers) and to its being driven by a far lower electric power. Cost reductions also derive from reduced costs of maintenance and/or repair, which in systems with direct radiation, as described above, is not possible, given the high number of loudspeakers involved.

[0008] These prerogatives of the horn system, generally described, need to coincide with another requirement, not yet described, and which, if not satisfied by the sound system, would detract from the importance of even the best performances. This requirement is the reduced dimension, which is as essential to the objective as the characteristics of sound volume and directivity.

[0009] It is already known that a horn sound system implies physical dimensions based on the frequencies that such a system must reproduce, all the more so if said frequencies are to be dispersed in the environment with a distinct and predictable directivity.

Since the system must be capable of reproducing a wide frequency band, in order to get the necessary fidelity, whether for the spoken voice or the production or reproduction of music, each single unit must be able to reproduce at least a band between 100 and 10,000 Hz (typically 50 - 15,000 Hz), with good linearity and homogeneity of angular emission. As far as the high frequencies are concerned, this requirement does not create great technical and design difficulties for limiting the size, except for the problem of controlling the dispersion angle. However, with regard to the low frequencies, especially the lowest, there are serious design and construction difficulties in containing the dimensions, because such frequencies are strictly connected to the physical dimensions, which must become increasingly greater the lower the frequencies to be reproduced and directed, to the point where they reach sizes that are prohibitive for the presuppositions and requirements mentioned above.

[0010] The diffuser which is the subject of this invention, however, is geometrically and acoustically designed in such a way as to respect the physical dimensions necessary for reproduction, both from the point of view of performance and quality, and from the point of view of controlling directivity of the low frequencies, without, however, penalising the reproduction characteristics of the mid and high frequencies.

[0011] It has been made by exploiting various different configurations contemporarily, using principles of physics in general and acoustic details applicable to a sound diffuser, benefiting from the advantages of each individual configuration or characteristic in order to get a positive result.

[0012] A first characteristic, the high performance,

has been obtained by using a very large horn with exponential expansion, folded into numerous concentric "rings" which define its development, from the throat to the mouth, in a radial as well as an axial direction, thereby, reducing the space taken up by the most awkward dimension, the length, by around six times, while keeping the other two dimensions the same, to give a directly proportionate acoustic performance.

[0013] A second characteristic, the high directivity, is obtained not only by the application of a physical principle, namely, that the bigger the planar dimension of the source, the greater the directivity at frequencies comparable or superior to the wave length corresponding to the same dimension, but also by another important improvement.

[0014] In fact, since exaggerated directional characteristics require horns with a large mouth and slow opening variation, which are difficult to make because of the prohibitive dimensions mentioned above, this particular and sophisticated design has had recourse to a further important improvement. This improvement is necessary to give the greatest possible directivity to the low frequencies, for which a path with exponential expansion has been calculated, using concentric rings to form a mouth ring or circular crown area at the end of the path, defined around a solid central element which is placed along the sound emission axis.

[0015] On account of the tight wave band for which it is calculated, this geometry, all other elements of performance being equal, gives the highest possible directivity for those specific dimensions.

[0016] Furthermore, this central element, besides forming an exit mouth for the horn with a ring area, equally importantly provides both the above-mentioned characteristics not only for the low frequencies but for the mid and high frequencies for which the horn in question, ending in a ring mouth, cannot be used without an unacceptable fall-off in the performance and quality.

[0017] This element consists of a large diameter paraboloid, placed co-axially to the direction of sound emission, at the same time forming one of the defining walls for part of the concentric ring conduit of the low frequency horn, as well as defining the body and acting as "baffle" for mounting the loudspeaker to be housed at its centre. In turn, the loudspeaker may be traditional, double cone, co-axial two channel, woofer and tweeter, with horn conduit either hidden beneath the dust cover or protruding axially at the emission cone of the loudspeaker itself.

[0018] The dimensions and geometry of the paraboloid are such as to give the necessary increase in performance and the desired directivity for that frequency band, beyond which the operation of the ring horn would be unsuitable.

[0019] Therefore, the whole system can function for the entire sound spectrum required with just one wide-band loudspeaker, or one wide-band double cone loudspeaker, or one co-axial loudspeaker with two channels, exploiting in all three cases back radiation in order to reproduce the lower frequencies via the ring horn.

[0020] Alternatively, there is the solution with one or more loudspeakers dedicated to the low frequencies which drive the throat of the concentric ring horn, whilst another loudspeaker, of one of the types mentioned above, is set to work in the required band, boosted by the front paraboloid.

[0021] This configuration of the diffuser parts, in addition to the advantages already mentioned, has that of making the sound emission coherent and aligned along the axis for the whole audio band reproduced, giving the significant advantage of regularity in the frequency and time responses. This is easily obtainable either with a crossover filter for the passive components, in the case of the co-axial loudspeaker with two channels or the three-channel system with separate basses, or with the use of active multi-channel amplification.

[0022] Last but not least are the potential external dimensions and limited weight of the diffuser, which make it ideally suited for insertion, either individually or grouped together, within standard sized false ceilings. Its design means that it can be constructed in any kind of material that can reproduce the shape, particularly in light and weather-resistant materials, like plastic, aluminium, etc. Its structure makes it intrinsically very rigid, the sound reproduction benefiting from the lack of parasitic resonance, thanks to those concentric rings that form the ring horn; the structure is self-supporting and facilitates the creation of "arrays" or multiple grouping of individual elements, with a vast range of power and sound projection, in addition to making soundproof covering easy to create for whatever area is needed, whether indoors or outdoors.

[0023] These favourable characteristics make it universally adaptable, suitable for all situations in which the sound needs to be directed to well-defined areas, with the best possible quality and intelligibility, whilst, at the same time, keeping undesired emissions outside the said areas to an absolute minimum.

[0024] The enclosed drawings, which are indicative but not binding, show various possible versions.

[0025] In these drawings:

- Figs 1-6 each show a different configuration of the sound diffuser according to the invention;
- Fig. 7 shows an example of a diffuser with a small front horn, which can be applied to any version of the diffuser;
- Figs 8, 8a and 8b show examples of possible uses of the diffuser, individually or in various combinations; and
- Fig. 9 shows an example of the diffusers positioned in order to contain the sound.

[0026] In each version, the diffuser has at least one active component in the centre, such as a loudspeaker 11, from which there extends a horn 12 with exponential

expansion.

[0027] In the example in Fig. 1, the loudspeaker 11 is placed in the centre of a front reflecting element 13, behind which there is a paraboloid reflector 14 which, together with the back of the said reflecting element, defines the horn 12.

[0028] The loudspeaker has a front emission 11 for certain high frequencies in front of the reflecting element 13 and a back emission 11" for other lower frequencies, which faces towards a compression chamber 15, from which the horn branches out. The latter expands progressively in a radial direction, terminating in a mouth 16 which opens in the front of the diffuser, all around the reflecting element, to give a sound emission in one single direction. The reflecting element may also contain a body 17, as needed.

[0029] In the versions shown in Figs 2 and 3, where elements are similar or the same as those in Fig. 1 (and, likewise, for the versions in Figs 4-6), the compression chamber 15 behind the loudspeaker has been enlarged. The horn 12 expands progressively from the compression chamber to the mouth bent into two (Fig. 2) or more (Fig. 3) concentric rings 18, created by zig-zag bends mid-way, practically parallel to the geometric axis of the diffuser and acting as impedance transformer.

[0030] The diffuser in Fig. 4, otherwise similar to that in Figs 2 and 3, has a horn 12 that expands progressively from the compression chamber 15 to the mouth 16 via intermediate bends 19 that are positioned almost radially to the geometric axis of the device.

[0031] The design of the diffusers shown in Figs 5 and 6 is similar to that of Figs 3 and 4, respectively, except that the central loudspeaker 11 is closed in at the back and there are one or two additional speakers 20 to give direct emission towards the horn 12.

[0032] In each of the versions, an additional horn 21 may be placed in front of the central loudspeaker 11, as shown in the example in Fig. 7.

[0033] Each of the above-mentioned diffusers may be used individually or in combination with other diffusers, placed in rows as shown in Figs 8, 8a and 8b or in a matrix. One possible but only indicative use for the diffusers is shown in Fig. 9, where they are placed on the ceiling, facing downwards, to give a precise direction and to contain the sound at the same time.

Claims

1. Wide-band sound diffuser, with high efficiency and directivity, **characterised by** the fact that it consists of a body with a parabolic front reflecting element (13), at least one active element (11) at the centre of said reflecting element, and a horn (12) which expands from the rear and around the reflecting element, in a chosen progressive way from the active element to the emission mouth (16), which faces in the same direction as the reflecting element, the active element having a front emission in the direction of the horn mouth and a back emission directed towards the horn.

2. Diffuser according to claim 1, in which the horn (12) is defined by a paraboloid reflector (14) placed behind the front reflecting element (13) and expands progressively in a radial direction, from a compression chamber (15) behind the active element up to the emission mouth, facing the same way as the said reflecting element.

3. Diffuser according to claim 1, in which the horn (12) expands progressively in a radial direction, from a compression chamber at the back of the active element to the emission mouth, via intermediate bends of concentric rings (18), co-axial with a geometric axis of the diffuser.

4. Diffuser according to claim 1, in which the horn (12) expands progressively in a radial direction, from a compression chamber behind the active element to the emission mouth, via intermediate bends (19), set radially to the geometric axis of the diffuser.

5. Diffuser according to any of the previous claims, in which the active element is a single loudspeaker (11) with rear emission towards the horn (12).

6. Diffuser according to any of the claims 1-4, in which there is a front active element loaded in the front reflecting element and at least one additional active element (20) pointing towards the horn, said front and additional active elements being loudspeakers.

7. Diffuser according to any of the previous claims, in which an additional horn (21) is foreseen on the front of the front active element.

8. Diffuser according to any of the previous claims, used individually or in combination with other diffusers, placed in rows or in a matrix, to direct and contain the sound.

9. Perfected wide-band diffuser, with high efficiency and high directivity, substantially as described, illustrated and claimed above and for the purposes stated.

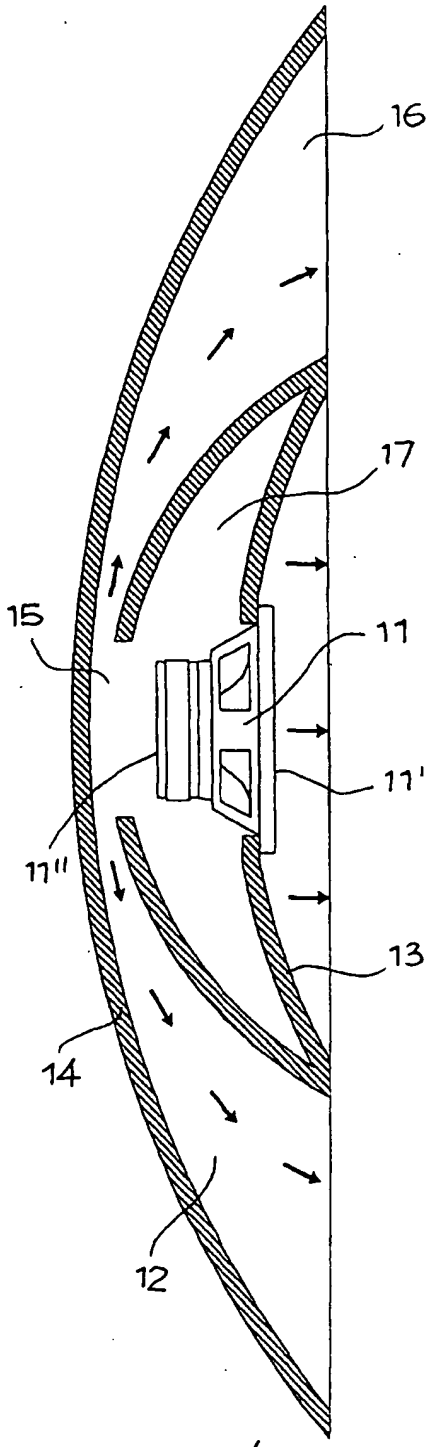

Fig.1

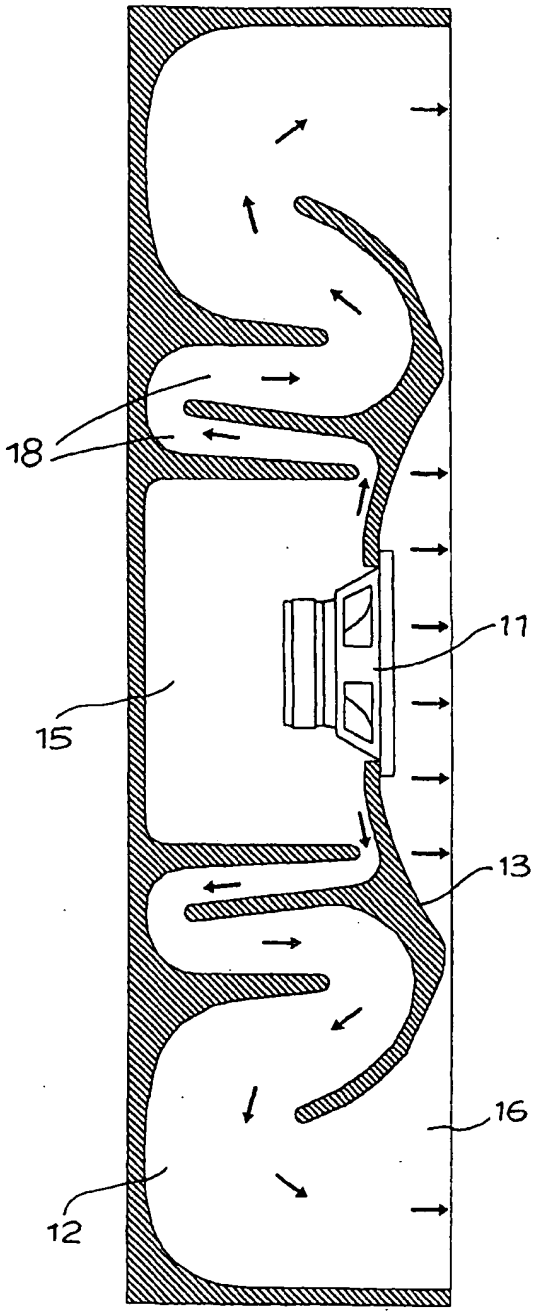

Fig.2

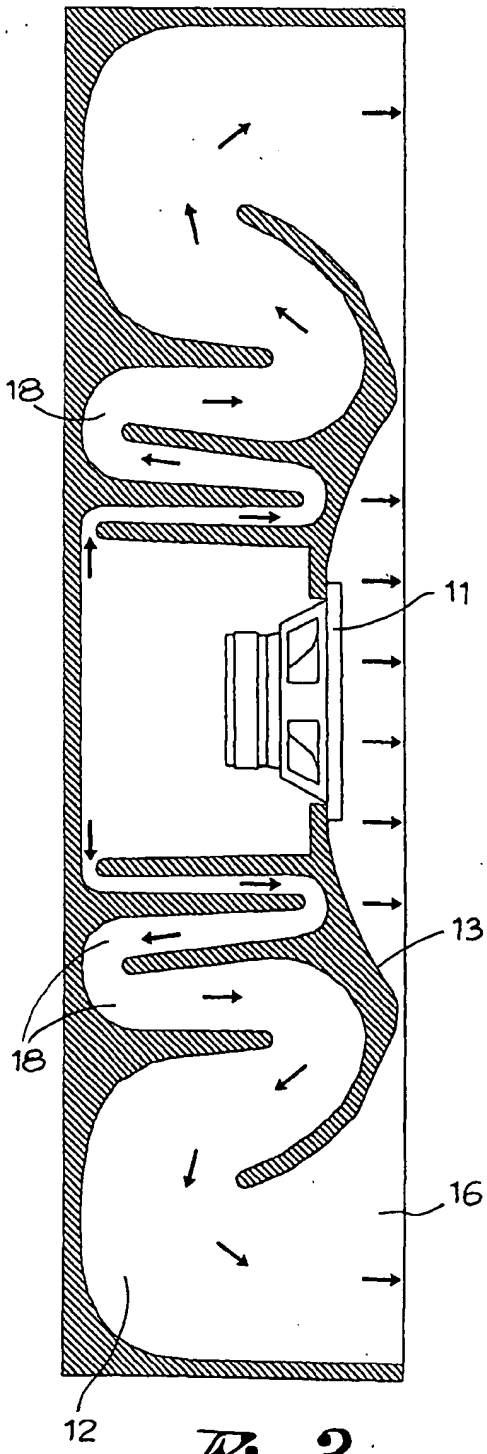

Fig.3

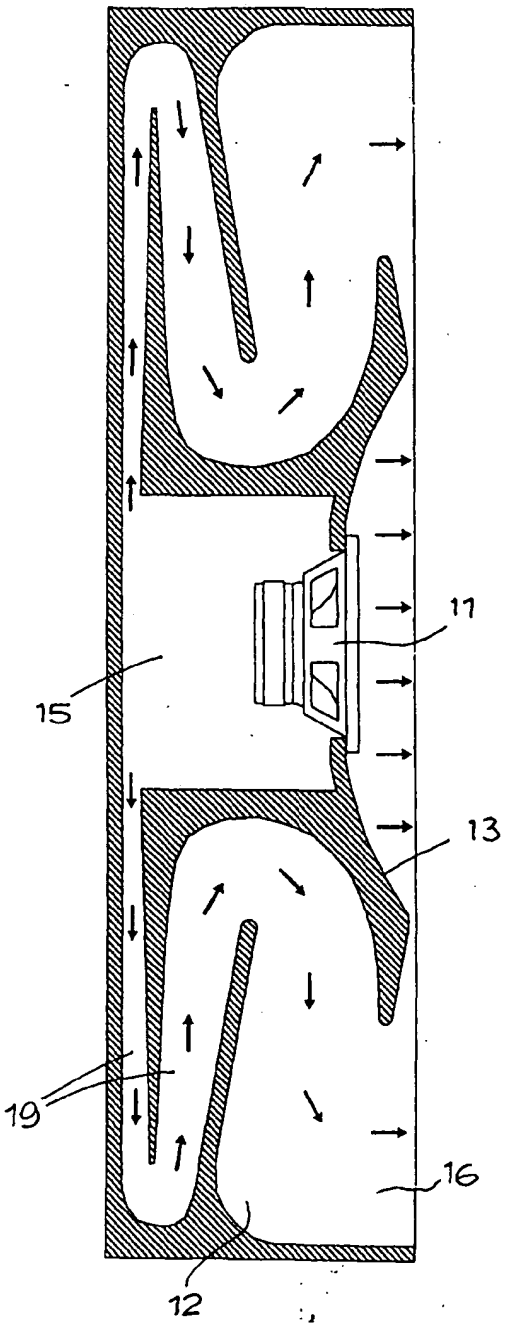

Fig.4

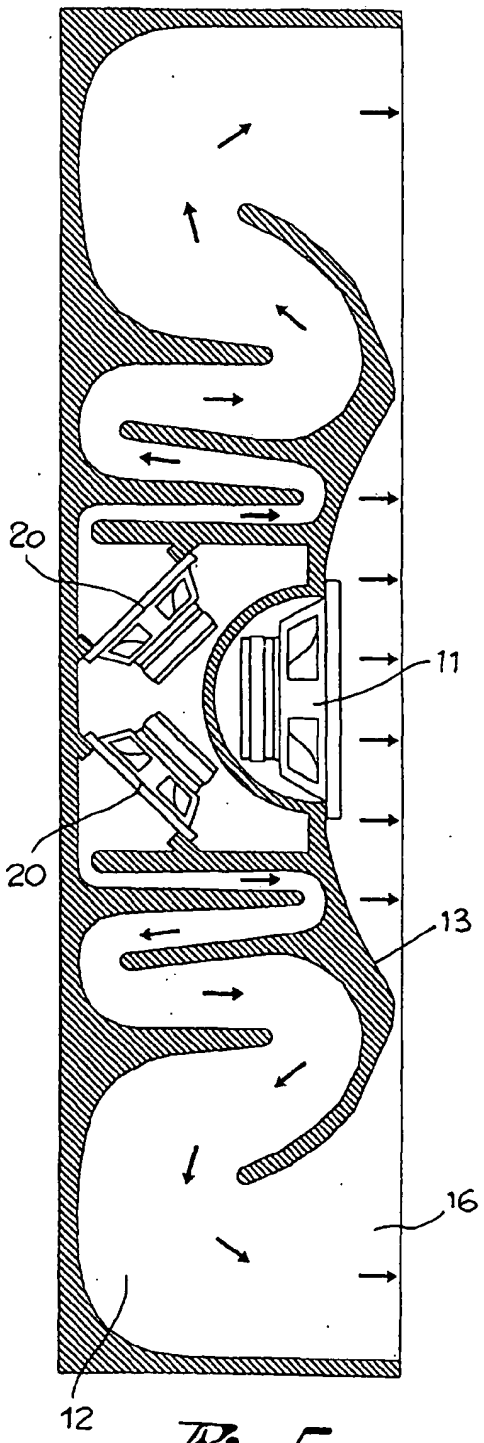

Fig.5

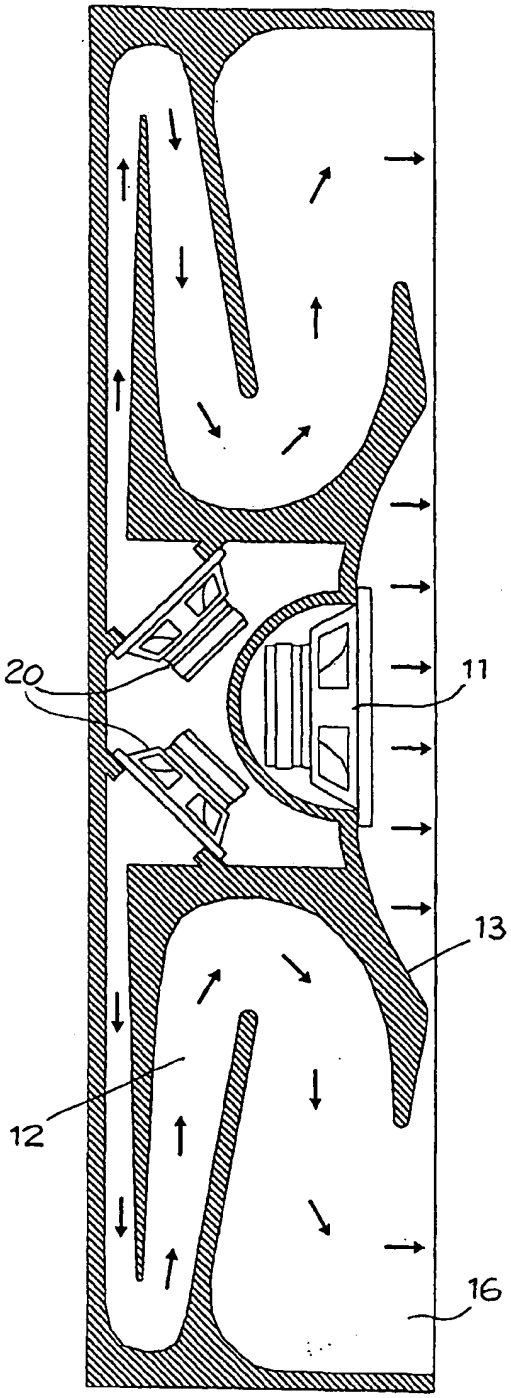

Fig.6

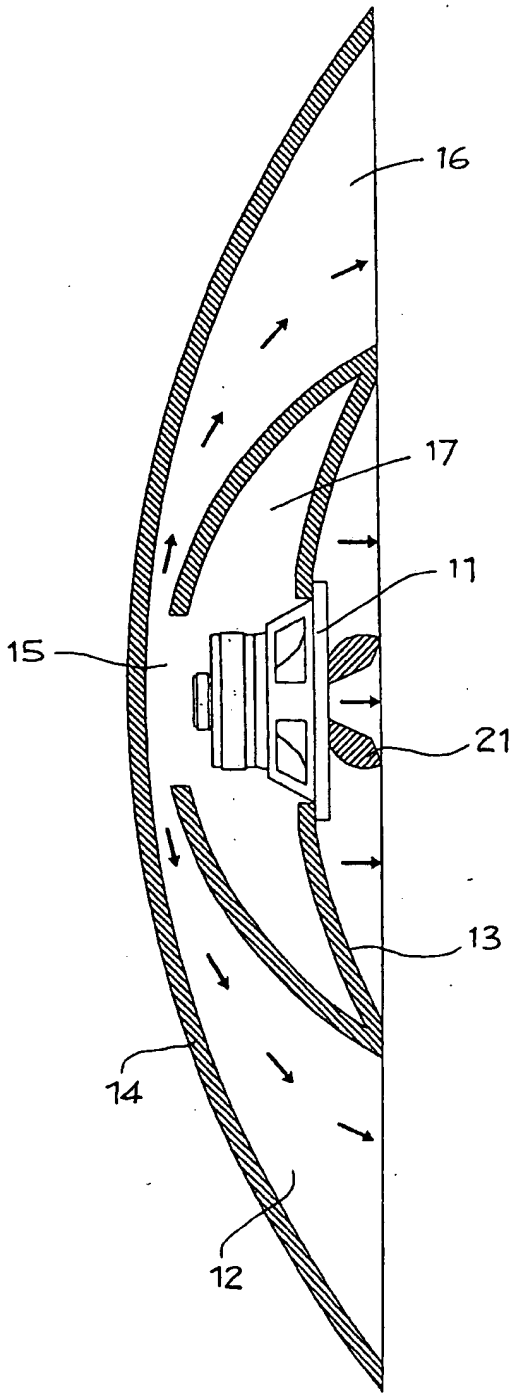

Fig. 7

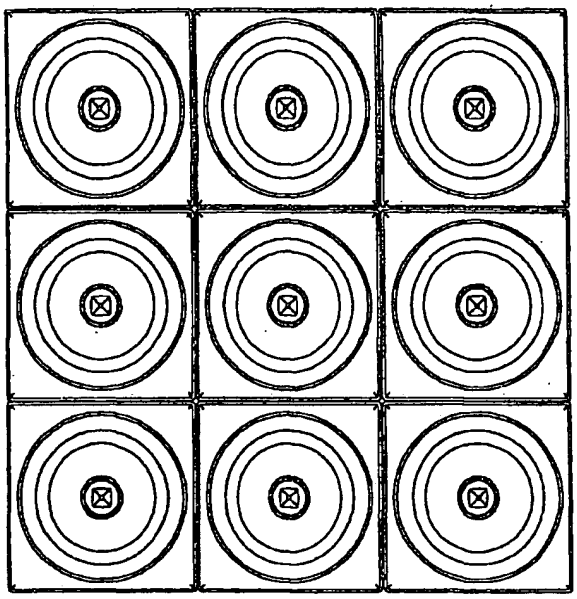

Fig. 8b

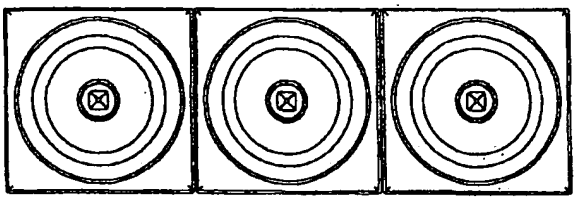

Fig. 8a

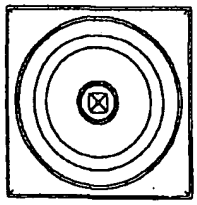

Fig. 8

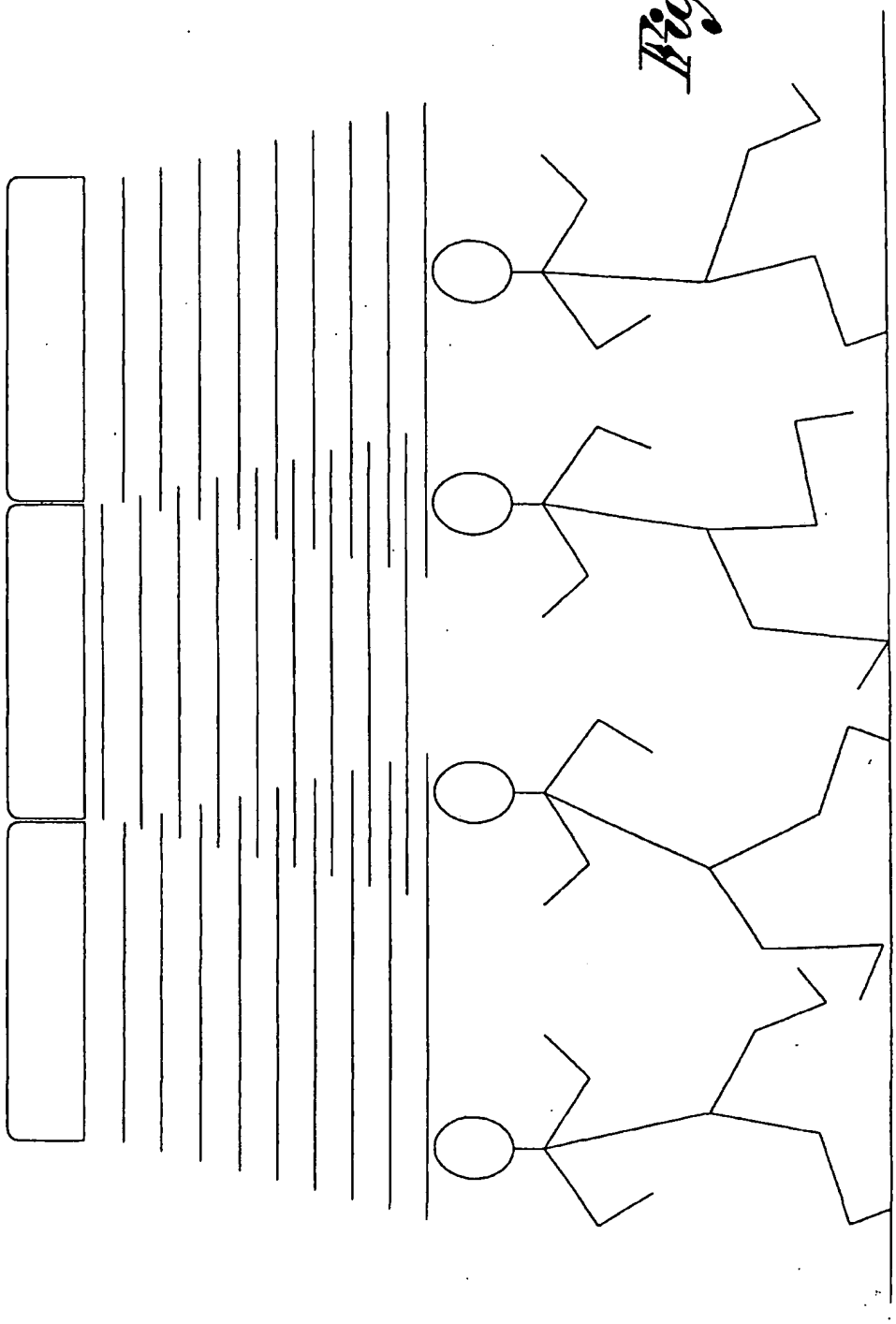

Fig.9